

How Gas Wells Leak

Gas wells leak from the outside up, then from the inside out.

Sooner or later, they all leak.

The DEC's proposed "enhanced requirements" for well construction will not keep Upstate drinking water from being gassed. Gas wells leak methane from the outside of the casing up, then from the inside out. As they rust out, all gas wells will eventually leak into groundwater. The only viable solution is adequate setbacks of gas wells from drinking water sources. Gas well setbacks in New York are the worst in the United States.¹



¹ <http://www.scribd.com/doc/72545747/Worst-Fracking-Regs>

The DEC's proposal to require a 3rd casing in gas wells will not solve the chronic problem of gas wells leaking methane into groundwater. This is due to three factors, none of which are solved by additional casings :

- 1. Methane is mobilized during the drilling process.** Every drill bit is operating in an uncased well-bore and any gas it encounters is going to be circulated up via drilling fluid through uncased sections of the well-bore. Most of this gas is captured by the gas separating unit on the drill rig, but not all of it.
- 2. Methane is released on the outside of the outermost casing.**² The outermost layer of cement will not adhere to certain types of rock, including shale. Cement shrinks over time, causing gaps to form that allows gas to flow upwards between the casing and the rock. Once this starts to happen, the well bore itself becomes a pathway for methane to pollute groundwater. See Figure 1 which illustrates how gas channels up between the outer casing and the surrounding rock.
- 3. All gas wells will eventually rust out and leak.** Not a matter of if, only a matter of when and how much. Unplugged wells will leak faster than plugged ones.³ Some well leaks can be repaired from the inside. Many wells will leak on the outside of the casing, which defy repairs.⁴ The Wall Street Journal reported that 1 in 10 new gas wells tested in Pennsylvania leaked. On a 10 well drilling site, the odds of leakage approach 100%.⁵ Over time, they are all apt to release methane into groundwater.

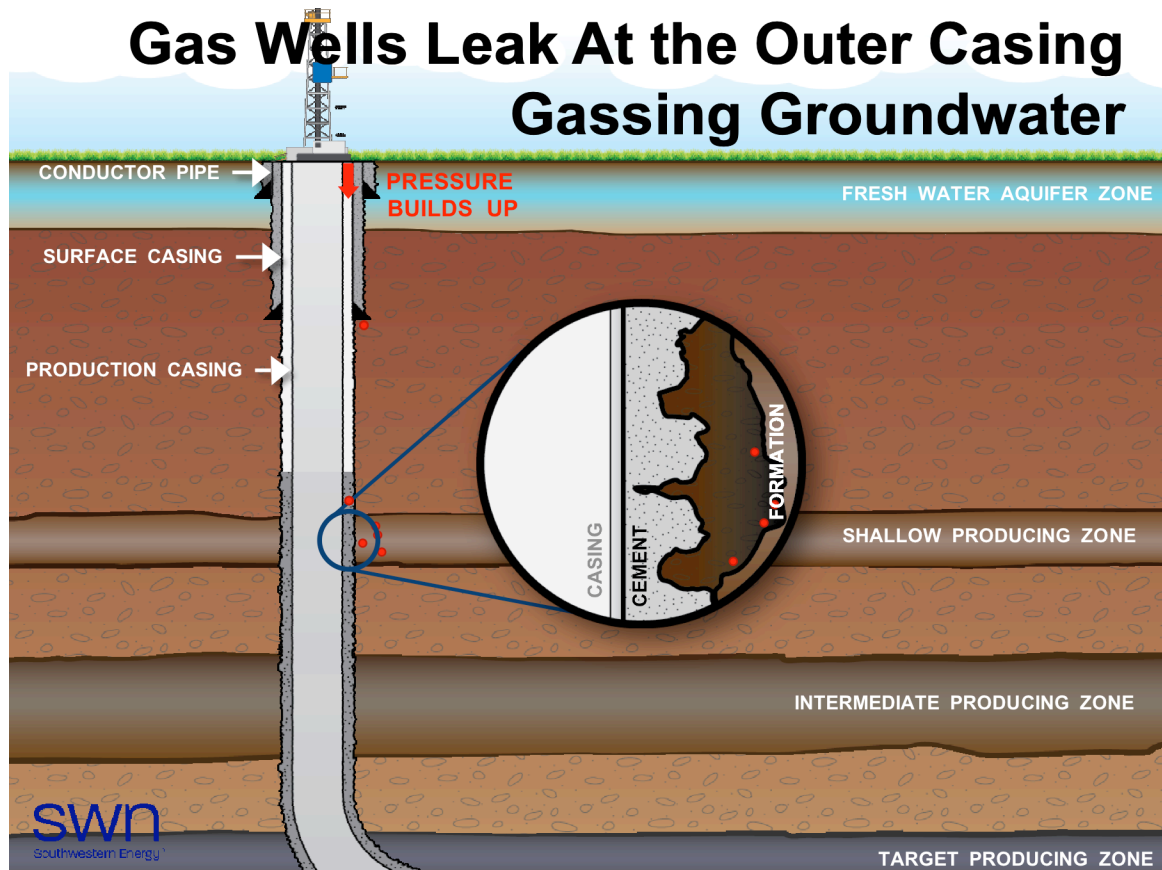
² <http://www.scribd.com/doc/65704543/Casing-Leaks>

³ <http://www.scribd.com/doc/77582900/Orphaned-NY-Oil-and-Gas-Wells>

⁴ <http://www.scribd.com/doc/80574646/Well-Failures>

⁵ <http://blog.shaleshockmedia.org/2012/03/13/its-not-the-fracking-frack-its-all-that-other-fracking-stuff-wsj-discovers/>

Figure 1 Methane Release Outside the Exterior Casing



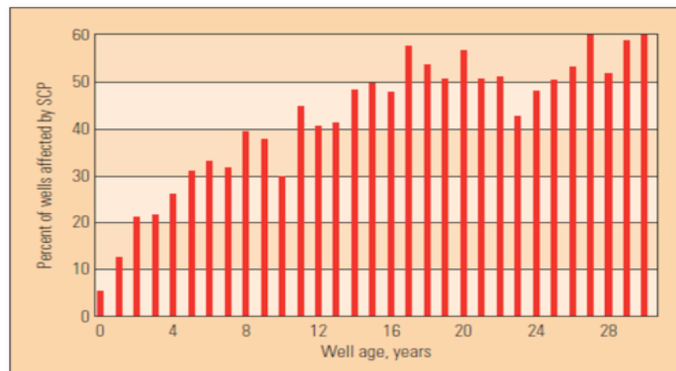
Evidence of such leaking can be observed within the casinghead at the bradenhead gauge as well as in the surrounding soil. Sustained casinghead gas pressures are common in the industry; indeed they are a chronic problem, as evidenced by Figure 2, which indicates that by the 5th year, 25% of the wells tested were leaking, and by the 8th year, 40% of the gas wells tested were leakers.⁶ These statistics tend to confirm the high rate of methane migration found by the research team from Duke In Pennsylvania. Gas wells leak. And all of them will leak eventually. Gas well leakage has been known to the industry for decades. The amount of leakage is immaterial from an economic standpoint – particularly if the gas channels up the outside of the

⁶ <http://www.scribd.com/doc/76174462/Schlumberger-Gas-Leak-Study>

casing. It has become an critical environmental issue now that thousands of gas wells are being drilled intensively in rural areas that are dependent on shallow groundwater wells – which are particularly prone to being contaminated with gas leaking from nearby wells. Unfortunately, the setbacks of gas wells in New York are the worst in the United States. Only 100 feet from a house and 150 feet from a school – which would be illegal in any other state or local regulations.⁷

Figure 2 Chronic Leaking of Gas Wells

Sustained Casing Pressure and Gas Migration Are Chronic Problems



^ Wells with SCP by age. Statistics from the United States Mineral Management Service (MMS) show the percentage of wells with SCP for wells in the outer continental shelf (OCS) area of the Gulf of Mexico, grouped by age of the wells. These data do not include wells in state waters or land locations.

Brufatto *et al.*, Schlumberger OilField Review, Autumn, 2003.

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Offshore or in a xeric environment, the environmental damage to leaking gas wells may be limited. But horizontal hydrofracking of gas wells faces unique environmental challenges in New York. The potential for environmental damage, particularly to groundwater, is greater than in the West, although there is ample evidence of gas wells leaking into groundwater in Western states.⁸ Upstate water wells are uniquely vulnerable since they tap groundwater which can become polluted by gas wells either as they are drilled, or as they

⁷ <http://www.scribd.com/doc/72545747/Worst-Fracking-Regs>

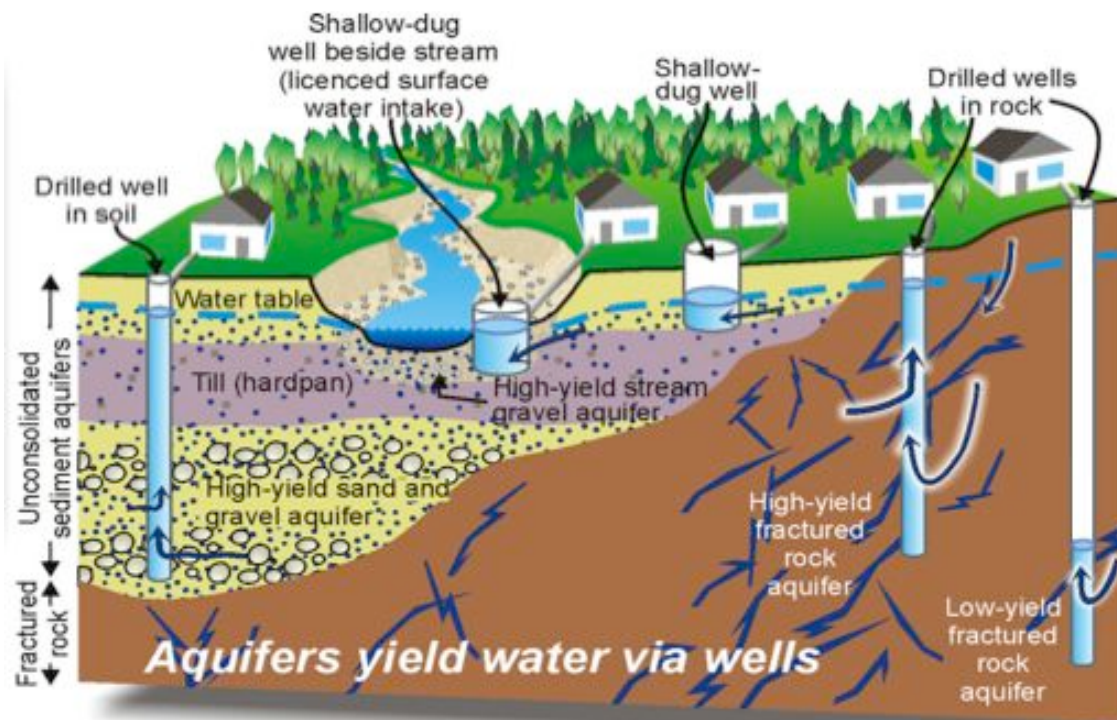
⁸ <http://tinyurl.com/fracking-aquifers>

age and start to leak. Western wells are less likely to become contaminated because they “mine” deep aquifers, many of which have no communication with groundwater, as shown in Figure 3 - with deep western aquifer wells on the right, and shallow Upstate groundwater wells in the middle.

The upshot is that thermogenic methane that is released from a gas bearing formation will be channeled upwards into groundwater by drilling or by leaking, rendering nearby wells un-potable. In Texas, where gas wells have been drilled near shallow water wells like those in New York, the exception proves the rule – the shallow water wells were polluted with methane, over 20 such shallow wells were polluted within 3,000 feet of a shale gas well in Parker County, Texas.⁹

⁹ <http://www.star-telegram.com/2011/06/23/3175947/parker-county-couple-sues-range.html>

Fig 3 Shallow Water Wells More Vulnerable to Being Gassed



The contamination of well water is not a major issue in Texas cities with municipal water supplies; Texas municipal wells tap deep aquifers and are not prone to contamination from the surface. Yet, the DEC has invoked municipal zoning standards, notably from the City of Fort Worth, in crafting its proposed generic regulations. This implies that the DEC thinks what works within the corporate limits of Fort Worth is applicable to the entire state of New York, which is hardly sound planning. There is no other justification on the draft SGEIS for the proposed 500-foot set back from a water well, which is 100' less than Fort Worth's. New York is patterning a critical catch-all regulation on a city with municipal water services in a semi-arid region in Texas. (Most setbacks in the proposed dSGEIS are wholly inadequate; the 100 foot setback from a house would be illegal in any zoning law that addresses gas drilling.)

See Water Well Testing Preliminary Revised Draft SGEIS 2011, Page 8-58

“Of the jurisdictions surveyed, Colorado and the City of Fort Worth have water well testing requirements specifically directed at unconventional gas development within targeted regions. Fort Worth’s regulations pertain to Barnett Shale development, where horizontal drilling and horizontal hydraulic fracturing are performed, and address all fresh water wells within 500 feet of the surface location of the gas well.”

There are obvious hydrological problems with this assertion. First, there are very few private water wells in Fort Worth - which is entirely served by municipal water lines – in accordance with state law. Of the few private water wells in the city limits (typically golf courses), none are shallow groundwater wells of the type found in rural New York. These Upstate groundwater wells are uniquely vulnerable to surface pollutants – from spills, etc. and from methane migration of gas drilling operations. Texas wells tap aquifers – not groundwater. Accordingly, a 500-foot setback that might be appropriate in a municipality in a semi-arid part of Texas would be wholly inadequate for Upstate.

Unlike Colorado, where drilling programs are reviewed as a group, *the DEC focus on individual wells does not consider the cumulative impact of multiple wells over an extended time period.*¹⁰ While the setbacks have increased from the first draft – from 50 feet from a municipal drinking water lake to 2,000 feet – they remain inadequate based on recent studies. There appears to be little rhyme or reason for some of the setbacks - other than population density for setbacks from drinking water sources, as previously noted. Most proposed setbacks and standards are similarly arbitrary and politically motivated.

The DEC acknowledges that methane is often mobilized by the drilling process into ground water, but disregards the fact that drinking water is rendered unpotable - as if that were a normal consequence of drilling. Poisoning people’s water wells is not acceptable. The 500-foot setback proposed from a water well is considerably less than the

¹⁰ <http://cogcc.state.co.us/RuleMaking/RulesLegislation/COGCC-Draft%20Rules-033108.pdf>

distances observed for methane migration into ground water in recent studies. This is the DEC's take on the recent study of methane contamination of shallow water wells by gas drilling operations:

Preliminary Revised Draft SGEIS 2011, Page 4-41

"In April 2011 researchers from Duke University (Duke) released a report on the occurrence of methane contamination of drinking water associated with Marcellus and Utica Shale gas development. As part of their study, the authors analyzed groundwater from nine drinking water wells in the Genesee Group in Otsego County, New York for the presence of methane. Of the nine wells, Duke classified one well as being in an active gas extraction area (i.e. a gas well within 1 km of the water well), and the remaining eight in a non-active gas extraction area. The analysis showed minimal amounts of methane in this sample group, with concentrations significantly below the minimum methane action level (10 mg/L) to maintain the safety of structures and the public, as recommended by the U.S. Department of the Interior, Office of Surface Mining. *The water well located in the active gas extraction area had 5 to 10 times less methane than the wells located in the inactive areas.*"

The DEC infers the safety of water wells from one data point out of sixty – which was one of a few outliers in the study. This is not just bad science, it's bad statistics. The New York water well "outlier" in the study was in fact not near an active gas well, it was near a newly drilled test well, Gastem's Ross 1, that never produced any gas.¹¹ *The DEC willfully misinterpreted the Duke study*, which tested 60 wells, most of which were in Pennsylvania, which clearly indicated that local water wells were highly likely to be contaminated by methane migration - and that the source of the methane was from the gas formations drilled (thermogenic), not from surface (biogenic) sources.¹²

"Methane concentrations were detected generally in 51 of 60 drinking-water wells (85%) across the region, regardless of gas

¹¹ <http://www.scribd.com/doc/73405864/Anomaly-in-the-Duke-Methane-Study>

¹² <http://www.pnas.org/content/108/20/8172.full>

industry operations, *but concentrations were substantially higher closer to natural-gas wells* (Fig. 3). *Methane concentrations were 17-times higher on average (19.2 mg CH₄ L⁻¹) in shallow wells from active drilling and extraction areas than in wells from nonactive areas (1.1 mg L⁻¹ on average; P < 0.05; Fig. 3 and Table 1).* The average methane concentration in shallow groundwater in active drilling areas fell within the defined action level (10–28 mg L⁻¹) for hazard mitigation recommended by the US Office of the Interior (13), and our maximum observed value of 64 mg L⁻¹ is well above this hazard level (Fig. 3).

The report, which was peer reviewed and published in *Scientific American*, went on to conclude:

“Overall, the combined gas and formation-water results indicate that thermogenic gas from thermally mature organic matter of Middle Devonian and older depositional ages is the most likely source of the high methane concentrations observed in the shallow water wells from active extraction sites.”

This means there is a high likelihood of shallow water wells being polluted by methane from drilling – from as far away as a kilometer (approximately 3,280 feet). As long as the DEC ignores the empirical evidence and invokes inappropriate standards from other locales, its assertion cannot be trusted.

Until another objective peer reviewed study conclusively contradicts the Duke findings, that report’s conclusions should guide the DEC in crafting its setbacks. There is no empirical, peer reviewed study to the contrary – only anecdotes. This is from the DEC, a regulatory agency which basically flunked its one and only outside review.¹³

Methane pollution of shallow water wells has not been a problem in Texas because there are very few ground water wells in the Barnett Shale area. Again, in the rare instances where such methane pollution has been observed, notably in Parker County west of Fort Worth – were from shallow water wells next to the Brazos River.

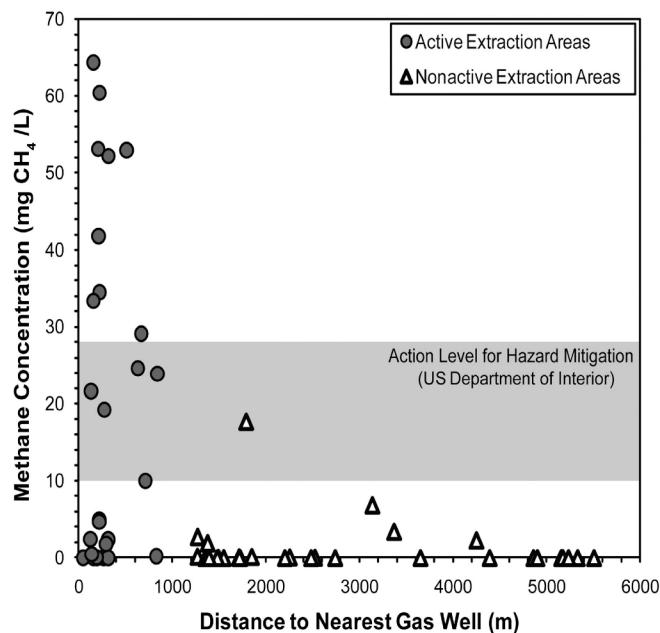
¹³ <http://www.scribd.com/doc/76085928/Worst-Practices-at-the-DEC>

These exceptions prove the rule. Shallow water wells get gassed by gas well drilling – the probability is a direct correlation of the distance between the gas well and the groundwater well.

The probability of polluting a shallow water well with methane is greater than 50% if the gas well is within 1,000 meters of the water well. Drilling can also pollute groundwater with drilling fluids. Upstate water wells are uniquely vulnerable to being polluted by drilling activities. None of the setbacks from surface water are adequate – 150 feet from streams, 2,000 feet from municipal drinking water lakes – no set-backs are proposed from private agricultural ponds or lakes, virtually assuring that many of them will be gassed with methane.

Figure 4 Methane in water vs. distance to gas well

Methane concentrations (milligrams of CH₄ L⁻¹) as a function of distance to the nearest gas well from active (closed circles) and nonactive (open triangles) drilling areas.



The proposed 500-foot setback for water wells in New York is wholly inadequate. It would virtually assure that many homeowners would have their wells gassed.

While fracking apologists assert that water contamination from shale gas wells is not a problem, *the industry is touting services to keep such wells from doing just that* - Schlumberger has admitted that cement sheath damage or “debonding” can allow “nuisance gas” to migrate to the surface and that there are “thousands of wells” that are impacted by this phenomena.¹⁴ Schlumberger can use the Duke study to sell their new cement.

New cementing techniques may prevent annular flow inside the well via cracks in the cement, but not radial flow of gas outside the casing into an aquifer. Once established, those pathways will allow methane to seep into groundwater.

Of course, some gas wells leak immediately due to faulty surface casing.¹⁵ And some wells leak catastrophically due to surface casing blow-outs.¹⁶ All wells will eventually leak, creating a pathway for methane and other pollutants to enter the groundwater tapped by shallow water wells. Unplugged wells will leak sooner than plugged wells, but as long as ferrous metal rusts, all of them will leak - it is simply a matter of when, as shown below in Figure 5 via multiple pathways, including through the plug itself, but sooner from the outside of the outermost casing, shown as insert ‘f’ in Figure 5. Such “orphaned” gas wells are already a problem in New York,¹⁷ and all of them will leak eventually, plugged or unplugged, with or without intermediate casings, with or without pricey cement jobs - into groundwater.¹⁸

¹⁴ http://www.slb.com/resources/case_studies/cementing/futur_suncor_central.aspx

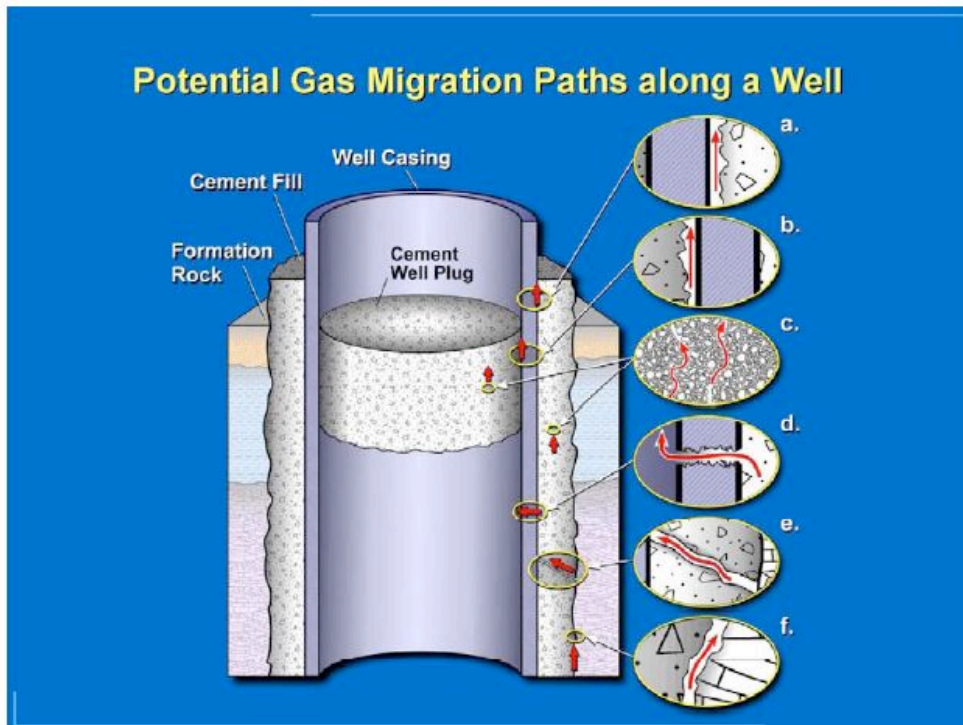
¹⁵ <http://www.cbc.ca/news/technology/story/2011/01/05/shale-quebec-bape.html>

¹⁶ <http://www.sfgate.com/cgi-bin/article.cgi?f=/g/a/2011/09/14/bloomberg1376-LRIO466K50YV01-2U431F97R2AA3VHP1OG0KNUH3E.DTL>

¹⁷ <http://www.scribd.com/doc/77582900/Orphaned-NY-Oil-and-Gas-Wells>

¹⁸ <http://www.propublica.org/article/deteriorating-oil-and-gas-wells-threaten-drinking-water-homes-across-the-co>

Figure 5 Pathways of Leaks From Gas Wells



Source: Alberta Energy Utilities Board

In tests conducted on 20,725 wells in Alberta, Canada, 15.5% were found to be leakers, 65% of which exhibited methane release into groundwater. If they are leaking outside the casing, that would defy repairs from the inside.¹⁹ Once a well starts to leak on the outside of the casing, there is no effective way to repair it. Simply adding more casing will not keep aging gas wells from leaking into groundwater.²⁰ Over time, they will all serve as vectors for methane into groundwater.

¹⁹ <http://www.scribd.com/doc/80574646/Well-Failures>

²⁰ <http://www.scribd.com/doc/76174759/Gas-Wellbore-Leaks>

In sum, the proposed requirement for an additional casing will not adequately protect water resources in Upstate New York from being polluted by gas wells.²¹ Nor will the DEC's token "one-size-fits-none" gas well setbacks protect water wells. Only adequate setbacks of gas wells from drinking water sources can do that. And there is no empirical evidence to suggest that a setback of less than a mile would be sufficient.

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<http://tinyurl.com/dSGEIS-Responses>

<http://www.scribd.com/northrup49>

²¹ <http://tinyurl.com/gas-well-leak>